BUS TRANSIT ALTERNATIVE FOR OAHU

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Department of Transportation Services

City & County of Honolulu

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A. INTRODUCTION & SUMMARY

The need for a balanced transportation system comprising of highways, buses and rapid transit has been recognized and supported as a matter of official policy for over 10 years by State and City leaders in Honolulu through the Oahu's comprehensive transportation planning process. As early as 1960, it was recognized that highways alone could not solve transportation needs in a cost-effective and environmentally sensitive manner and local planning agencies and civic leaders began to support the concept of expanding the bus system and investigating the potential of a rapid transit system. In 1966-67, the Oahu Transportation Study, funded jointly by Federal, State and City agencies, developed a long-range transportation plan for Oahu which included highway and bus system improvements and a rapid transit component. The final study report contained a makai freeway-expressway recommendation, an expanded bus system, and a rapid transit line through urban Honolulu from Pearl City to Hawaii Kai, supported by a feeder bus system which would serve the whole island. In 1967, this plan was accepted by the Oahu Transportation Study (OTS) Policy Committee as the long-range plan to guide integrated, comprehensive development of transportation facilities on Oahu for the next 20 to 40 years. To date, except for certain modifications to the highway network which deletes

the makai freeway (in December 1971) and accepts the rapid transit route developed during the PEEP I Study (in March 1973), this plan has been continually reaffirmed by the Oahu Transportation Planning Program (OTPP), successors to OTS, and more recently by the Oahu Metropolitan Planning Organization (OMPO), successors to OTPP. Both State and local transportation policy makers are represented on the governing body of the OMPO.

The OTS also recommended that a short-range, interim plan be developed for improving and expanding the existing bus system to prepare for its integration into the feeder systems when the fixed facility is available. In 1971, the City conducted further study of the bus system and concluded that various privately-owned lines should be integrated under City ownership. This was carried out in the same year and since that time under City & County management, the bus system has been expanded and improved to the point that it is recognized as one of the better systems in the U.S.

Progress has also been made on the fixed guideway system. In 1971-72, the Preliminary Engineering and Evaluation Program, Phase I (PEEP I) was conducted and resulted in the definition of the basic fixed guideway transit corridor and system. The system

was designed to improve access to major activity and employment centers in Central Honolulu, and to provide an attractive alternative to the private automobile. PEEP I recommended an island-wide network of local and express buses, operating both in mixed traffic and in reserved bus lanes. Buses would be integrated with a high capacity, fixed guideway rapid transit system extending from Pearl City, through the urban core, to Hawaii Kai.

As a supplement to the Phase I Study in early 1973, the State and City jointly funded a second study to perform additional evaluation on a modified personal rapid transit (PRT) system and a busway system as alternatives to the previously recommended fixed guideway system. When the study concluded that either of these alternatives would be more expensive than the fixed guideway system, the State agreed to support the City with the PEEP II effort.

PEEP II's primary objective was to execute more advanced planning and preliminary designs necessary to define the fixed guideway and feeder bus system features and requirements. At the same time, the Urban Mass Transportation Administration (UMTA) began formulating its policy on the requirement for a comprehensive analysis of transit alternatives by all cities or regions contemplating a major transit investment and Honolulu was requested to conduct such an analysis.

The UMTA policy on alternatives analysis sets forth specific objectives and principles in conducting the study. For long-range planning, the policy states that "proposals for major mass transportation investments shall be consistent with an urban area's comprehensive long-range plan which articulates the overall direction for metropolitan development and identifies major transportation corridors".

The long-range transit alternatives analysis was conducted to determine the type of transit system that would best meet Oahu's long-range planning objectives and policies. It was determined that a high-capacity rapid transit system operated on exclusive, grade-separated rights-of-way was needed to meet future travel demands of central Honolulu. It was further concluded that a fixed guideway rapid transit would best promote the island's social, economic, environmental and urban development goals and support national aims and objectives.

Since long-range planning normally encompasses a time frame of 20 - 25 years into the future, the year 1995 was adopted as the study year for long-range transit planning for Oahu. Various population and employment forecasts existed and the OTPP policy committee, in 1971, adopted 924,000 as the most realistic population projection for 1995. Subsequently, the State DPED's

Series E-2 projected a population level of 965,000 which was used by different agencies in various studies. However, for rapid transit planning, the 924,000 projection was maintained for all planning analyses.

In late 1977, the State DPED modified its forecast downward to 881,000 for 1995 or approximately 5% lower than the 924,000 used in the rapid transit analysis. A slightly larger change was in employment with a forecast of 479,000 or approximately 7% less than that used in the rapid transit analysis. It is however important to point out that up to 1990, the forecasts are essentially the same.

Nevertheless, it should be recognized that any long-term projections are highly speculative and extreme caution should be taken in assessing programs which require justification on long-term basis. Where major public expenditures are involved, this becomes critical to decision-makers especially where there are many competing programs for the limited public funds. In order to assist in better understanding the implications of alternative courses of action relative to public transit on Oahu, this report presents a general overview of continuing with an all-bus system for the near-term as well as for a longer period.

The more recent transit planning effort has reaffirmed the need and justification for a rapid transit system and further concludes that a fixed guideway rapid transit can best serve the long-range transportation needs of the area. This conclusion was concurred with by UMTA in late 1976 after reviewing the alternatives analysis study conducted by the City which included bus transit alternatives.

Although all previous studies have shown the need for and feasibility of a fixed guideway system in urban Honolulu, the questions that still persists is: "can an all-bus system do the job?" The purpose of this report is to examine this question in detail by assessing the cost-effectiveness of bus vs. fixed guideway and the capacity of existing streets and highways to accommodate more buses.

The remainder of this chapter summarizes the basic findings of this examination, which are discussed in more detail in the following chapters.

1. The Existing Bus System

Honolulu operates one of the most productive bus transit systems in the U.S. It has adopted a short-range transit improvement plan to continually improve transit service but at a modest level in order to permit an orderly change over to feeder operation when the fixed guideway system becomes operational. Even with this modest improvement in service, operating cost and deficit have and will continue to increase each year, especially if current fares are maintained. The following table is presented to illustrate the magnitude of the operating costs and deficits that can be anticipated up to 1985.

	1974	1975	1977	1980	1985
Bus Fleet	300	300	350	400	450
Annual Ridership (million)	36.2	44.6	54.4	57.0	65.0
Operating Cost (million)	$10.1	$14.4	$25.0	$28.1*	$30.6*
Fare Revenue** (million)	$ 6.8	$ 8.0	$ 9.6	$10.3	$12.1
Deficit (million)	$ 3.3	$ 6.4	$15.4	$17.8	$18.5

* Cost in 1977 dollars
** Fare revenue based on current fare schedule

If operating costs are escalated at 8% per year, the 1980 & 1985 operating deficits will be $25.1 million and $44.5 million respectively, assuming that current fares are maintained.

2. The Expanded Bus System

Honolulu has the option of continuing with bus transit at about the same level of service as currently provided or by greater improvement in the level of service through substantial fleet expansion with TSM improvements to obtain higher operating speeds and schedule dependability. The expanded bus system was designed to test the productivity and operational feasibility of a significantly improved bus service. It was found that ridership could be substantially increased assuming that TSM improvements could be implemented, but would result in a corresponding increase in bus fleet size and operating cost. The following table summarizes the projected ridership, operating cost, and revenue for the expanded bus system.

	1980	1985	1990	1995
Bus Fleet	498	637	776	914
Annual Ridership (million)	70.0	83.6	97.3	110.9
Operating Cost* (million)	$37.0	$47.0	$57.0	$ 68.0
Fare Revenue** (million)	$14.3	$17.3	$20.2	$ 23.2
Deficit (million)	$22.7	$29.6	$29.6	$ 44.8

* Cost in 1977 dollars
** Fare revenue based on current fare schedule

If operating costs are escalated at an assumed escalation rate of 8% per year, the deficits for the above listed years will be $28.6, $53.9, $100.1, and $179.2, assuming that current fares are maintained.

3. **Cost Comparison with Grade-Separated Alternatives**

There is added cost associated with improved transit service irrespective of the transit system type. The cost of improving transit service with an all-bus system which operates on existing streets and highways will, as demonstrated earlier, continue to grow with each incremental increase in service. In fact the all-bus system, due to a combination of its labor intensive characteristics and reduction in operating speed as street and highway congestion worsens, will increase at an increasing rate over time.

High operating speeds are necessary to both attract ridership and reduce operating cost which can be attained by providing transit system operating on exclusive grade-separated rights-of-way such as busway or fixed guideway rapid transit systems. The following table shows the comparison of the 1985 ridership, operating cost, revenue and deficit for alternative systems.

	Expanded Bus	7-Mi. Busway	14-Mi. Fixed Gwy.
Annual Patronage	83.6	94.2	97.4
Operating Cost*	$47.0	$42.0	$40.0
Revenue (current fare)	$17.3	$19.9	$20.8
Deficit	$29.7	$22.1	$19.2

* In constant 1977 dollars

In order to obtain lower operating costs, capital investment must be made in acquiring rights-of-way and constructing the grade-separated facility. Depending on the ridership volume and the condition of available streets and highways for bus operations, a point is reached whereby the investment in exclusive, grade-separated transit facility becomes economically justified. Where a natural, high volume travel corridor exists in an area together with a propensity for transit usage as exists in central Honolulu, this investment becomes warranted even with a relatively small metropolitan population.

From the following table, it can be readily seen that the investment in the 14-mile fixed guideway becomes economically advantageous between 1985 and 1990 based on using constant 1977 dollar operating costs and current fare revenues. However, if operating costs and fare revenues are both escalated at 8% per year, then the fixed guideway investment becomes economically justified even before 1985. Of course in making economic analysis, it is more appropriate to use constant dollars in lieu of escalated dollars.

COMPARISON OF COST & REVENUE

CONSTANT 1977 DOLLAR OPERATING COST & REVENUE

	Expanded Bus		7-Mi. Busway		14-Mi. Fixed Gwy.	
	1985	1990	1985	1990	1985	1990
Annual Capital Cost*	1.0	2.0	9.5	10.5	12.5	13.5
Annual Operating Cost	47.0	57.0	42.0	53.0	40.0	48.0
Total Annual Cost	48.0	59.0	51.5	63.5	52.5	61.5
Revenue (current fare)	17.3	20.2	19.9	24.9	20.8	26.1
Net Annual Cost	30.7	38.8	31.6	38.6	31.7	35.4

ESCALATED OPERATING COST & REVENUE

Annual Capital Cost*	1.0	2.0	9.5	10.5	12.5	13.5
Annual Operating Cost**	86.9	155.0	77.7	144.2	74.0	130.6
Total Annual Cost	87.9	157.0	87.2	154.7	86.5	144.1
Fare Revenue***	32.0	54.9	36.8	67.7	38.5	71.0
Net Annual Cost	55.9	102.1	50.4	87.0	48.0	73.1

* Based on 20% local share of capital cost and amortized over 25 years @ 6%

** Based on Escalated Cost at 8% per year

*** Revenue based on current fares increased at 8% per year

4. Impact on Street & Highway Capacity

Although a program may be economically sound it is often deferred due to other competing and high priority programs, all of which are competing for the same limited public funds. Since programs have to be justified on technical and social-economic needs, it is necessary to assess these needs and the consequence of not implementing the program.

The expanded bus system has the potential of attracting increasing ridership, although not as much as with busway or fixed guideway systems, and with minimal capital expenditure. However, these buses are competing with the automobiles and where streets and highways are already strained with volumes approaching or exceeding capacity, there is little doubt that some form of added transportation capacity must be provided in the near future.

With the expanded bus system two critical areas exist in terms of transportation capacity - the downtown streets and the arterials and highways serving the urban Honolulu core. The number of peak hour buses projected for the selected years were tested for auto traffic impact as the result of reduction in street capacities due to increased volume of buses. In the downtown area, both the east-west and north-south streets are critical especially at intersections where heavy turning movements occur.

These heavy turning movements occur at such locations as Beretania Street makai on Richard and Bishop Streets and mauka on Queen Emma Street and Nuuanu Avenue. Segments of King Street, Queen Street, and Ala Moana/Nimitz Highway all experience heavy east-west movements. Currently, most of the east-west buses are routed on Hotel Street but with a large projected bus volume, all east-west streets will have to accommodate buses in the future with varying levels of impact on traffic. Principal north-south streets are the Nuuanu-Bethel and Bishop-Alakea one-way couplets which will also be severely impacted by heavy bus volumes projected under the expanded bus system.

In downtown Honolulu, auto traffic could grow conservatively by at least 25% by 1990 and the increase in bus volume estimated to reduce available street capacity by approximately 15%. The net result is an equivalent increase of some 40% over today's traffic condition which is already at or exceeding capacity at many locations.

Equally critical is the impact of the expanded bus system on major arterial and highway capacities. Volume to capacity analysis indicates that the volume will exceed capacity by 1990 for critical screenlines at Punchbowl Street and Ward Avenue.

5. Compatibility with the General Plan Policies

The decision to implement or not implement the rapid transit system could have a significant impact on urban growth and development on Oahu. The General Plan of Honolulu establishes desired population levels in various districts of Oahu. More specifically, the central Honolulu district is planned to accommodate a substantial portion of the growth based on the assumption that a rapid transit system would be available. This population growth would be accommodated through increased density in selected locations along the transit corridor.

An all-bus transit system would not be compatible with the General Plan policy and furthermore, if the decision to go with the rapid transit system is unduly delayed, development may take place without the positive influence for shaping this development pattern to be compatible with the future rapid transit system.

6. Immediate Need for TSM Legislation

With an all-bus system, traffic condition can only worsen as the available transportation capacity deficiency continues to grow to a point where general mobility on Oahu becomes constrained. In order to mitigate this eventual condition, immediate steps should be taken to obtain gradual public acceptance of any mitigative measures.

Experience throughout the U.S. has shown that people strongly resist any changes to their life-style including complete freedom to travel which they currently enjoy. Our experience on Oahu with the car-pool program in 1974 and the current van-pool program have been less than encouraging. Both at the local and national levels, experience has consistently shown that these measures do not work voluntarily and need greater incentives or legislation to compel people to alter their travel habits.

Measures to reduce peak period traffic volumes through increased vehicle occupancy and by stretching peak hour travel demand with staggered work hours are few of the more promising measures if accepted by the travelling public. However, measures that would restrict essential trips in specified area or time periods are not without serious social and economic consequences unless a reasonable alternative is provided. Therefore, a comprehensive program of

transportation system management should be immediately started with the objective of formulating specific legislative measures which can be enacted after thorough public airing and input.

B. THE EXISTING BUS SYSTEM

1. General

Description of the existing bus system operations and a plan for nominal growth is presented as the minimum bus transit plan for the near term. This analysis is presented for use as the basis for relating the expanded bus system features and fiscal requirements for the same period of time.

The existing bus operations consist of a fleet of 350 buses of which approximately 300 are used during peak periods. During FY77, nearly 55 million passengers used the system which made it one of the most productive bus systems in the U.S. With a relatively low fare schedule of 25¢ for adults, 10¢ for students, and free fare for senior citizens and handicapped, and free transfers, some $9.6 million in revenue was collected. The operating cost was nearly $25 million giving a revenue to cost ratio of nearly 40%. The City received Federal subsidy grant of $2.3 million with local subsidy amounting to some $13 million.

2. Near-Term Improvement Plan

Based on the City's Short-Range Bus Plan, a fleet expansion to 400 buses is contemplated by 1980 with a continuing

modernization program through 1982 but maintaining the fleet at 400 buses. Although the City's current Short-Range Bus Plan is carried only to 1982, an assumed increase of the bus fleet by 1985 to 450 is analyzed.

Table 1 shows the existing 350 bus fleet, the planned 400 bus fleet by 1980, and an assumed expansion to a 450 bus fleet by 1985 with costs and revenues, both in constant 1977 dollars and in escalated dollars based on 8% escalation rate.

TABLE 1
EXISTING BUS SYSTEM - COSTS & REVENUES

	1977	1980	1985
Bus Fleet	350	400	450
Annual Ridership (million)	54.4	57.0	65.0
Constant 1977 Dollars			
Operating Cost*	$25.0	$28.1	$30.6
Revenue (current fares)	$ 9.6	$10.3	$12.1
Deficit	$15.4	$17.8	$18.5
Escalated Dollars			
Operating Cost	-	$35.4	$56.6
Revenue (current fares)	-	$10.3	$12.1
Deficit	-	$25.1	$44.5

3. Operating Subsidy Analysis

A public transit system provides valuable public service to all segments of the travelling public. Without it, some people would be deprived of essential mobility such as going to work, the doctors' offices, visit relatives, schools, etc. Honolulu's bus transit provides this essential service to virtually all communities on the island - 7 days a week, 365 days a year.

Relative to the bus fare structure, there are 3 basic fares - adult fare of 25¢, student fare of 10¢, and free fare for senior citizens and the handicapped. Based on these fares which have been in effect for some time, operating deficits would as expected continue to increase each year with increasing cost of labor, fuel, and materials. With the expected increase in operating deficit each year, it is well to analyze the composition of the deficit as shown in Table 2.

TABLE 2
OPERATING SUBSIDY ANALYSIS

Group	Annual Ridership (Million)	Actual Cost Per Ride	Actual Cost By Group	Actual Revenue	Subsidy By Group	% Of Total
Adults	32.2	46¢	14.80	$ 8.10	$ 6.70	44%
Students	14.8	46¢	6.80	$ 1.50	$ 5.30	34%
Sr. Citizens	7.4	46¢	3.40	-0-	$ 3.40	22%
Total	54.4		$25.00	$ 9.60	$15.40	100%

Based on actual operating data for FY77, the average cost per ride was 46¢. If everyone paid 46¢, then there would be no deficit. However, the fares as currently established are below the break-even rate for all groups in varying amounts. It is interesting to note that even if adult fares were raised to the break-even rate of 46¢, there would still remain a substantial deficit due to reduced or free fare for the other groups.

This analysis merely shows that transit subsidy paid by the general public to meet the vital social needs of our community and not just to subsidize those adults who are paying only 25¢ per ride. Over 25% of the transit users are school children who can ride the system for 10¢ to go to and from their schools. If the City did not provide this service, the State DOE would have to provide school bus

service in urban Honolulu similar to those provided in rural Oahu and the outer islands. Nearly 14% of the transit riders are senior citizens, many of whom would have no means of travelling without the bus system. The City's bus transit is indeed providing a valuable public service and when one recognizes those segments of our community who are dependent on it, the operating subsidy does not loom so large.

C. THE EXPANDED BUS SYSTEM PLAN

1. General

The expanded bus system plan is designed to attract increased transit ridership by providing improved transit service encompassing more frequent service and the application of transportation system management (TSM) techniques to improve or maintain bus operating speeds and schedule even with increasing traffic congestion. Service frequency improvements basically require more buses to be operated and hence a larger bus fleet. Speed and schedule improvements require the use of roadways that are not heavily congested or where heavy congestion exists to provide priorities for bus operations over automobiles. This is normally accomplished by reserving lanes for the exclusive use of buses or as more commonly done by reserving lanes for buses and high occupancy vehicles (HOV) on highways.

The expanded bus system plan was limited to the use of existing or planned roadway facilities and does not reflect capital expenditures for new facilities. It is based on the premise that certain modifications to existing facilities would be required and made. Any improvements to the highway system such as providing HOV lanes were assumed to be part of the State DOT's on-going highway program while reserving lanes on city streets would entail only minimal costs in terms of signing and striping.

2. Description of the System & Routes

Using the existing bus routes currently serving Oahu as the basic system network, the EBS network was developed for modal split analysis to obtain ridership volumes. The EBS network reflected the improved service to be provided through more frequent service and higher operating speeds than the existing bus service. The results of this analysis provided the projected ridership volumes and the required bus fleet as shown in Table 3.

TABLE 3
PATRONAGE ESTIMATE & BUS FLEET SIZE

	1980	1985	1990	1995
Annual Patronage (million)	70.0	83.6	97.3	110.9
Bus Fleet	498	637	776	914

The required bus fleet size is the result of analyzing each bus route and the required number of peak period buses to accommodate the anticipated ridership volume. Table 4 shows each route and the 1980 and 1995 maximum bus requirements.

Each of the bus routes passing through downtown Honolulu was then analyzed and the total number of peak hour buses was identified on each of the various streets in the downtown area and at different locations on these streets as shown in Table 5. As can be seen from some of

TABLE 4

EXPANDED BUS SYSTEM
ROUTE DESCRIPTION AND NUMBER OF VEHICLES REQUIRED

ROUTE NO.	ROUTE DESCRIPTION	MAX. VEH. REQUIRED 1980	MAX. VEH. REQUIRED 1995
LOCAL BUSES:			
1	LUNALILO HOME ROAD-UMI LOOP	6	9
2	HAHAIONE VALLEY-UMI LOOP	8	12
3	AINA HAINA-UMI LOOP	6	9
4	KAHALA MALL-UMI LOOP	17	24
5	KAPAHULU-LILIHA	18	34
6	KAPIOLANI-MIDDLE STREET	27	51
7	KAHALA MALL-AALA	14	20
8	AALA-NAVY SUPPLY	1	1
9	NAVY DISPENSARY-AALA	8	10
10	NUUANU-PUNAHOU-WAIKIKI	38	76
12	MANOA-WAIKIKI	6	9
13	WOODLAWN-PAUOA	9	14
14	KALIHI SHUTTLE	5	8
15	WAIKIKI-HICKAM	18	37
16	WAIKIKI-CBD	10	19
17	PALOLO-AALA	17	25
18	KALIHI (KAM IV)- ALEWA	2	2
19	FOSTER VILLAGE-UMI LOOP	6	11
20	TRIPLER TO UMI LOOP	2	2
21	ST. LOUIS-MAUNALANI	7	9
24	PACIFIC HGTS. -AMC	3	3
25	AIEA HGTS. -AMC	6	10
26	PACIFIC PALISADES	4	7
27	CBD-HIC SHUTTLE	1	1
32	PEARL CITY	6	8
33	WAIPAHU	4	8
34	MAKAHA-NANAKULI-AMC	5	8
35	IROQUOIS POINT-WAIPAHU-CBD-AMC	11	18
36	WAIMANALO-KEOLU-KAILUA-CBD-AMC	5	11
37	WINDWARD COMM. COLL. -KAILUA-CBD-AMC	1	1
38	LANIKAI-KAILUA	1	2
39	CIRCLE ISLAND	12	36
40	CIRCLE ISLAND	10	16
41	LUALUALEI HMSTD-LUALUALEI NAVAL BASE	1	1
42	MAKAHA-WAIANAE VALLEY	1	1
43	MAKAKILO-CAMPBELL SHUTTLE	1	5
44	MAKAKILO-BARBER'S PT-EWA-WAIPAHU	3	5
46	WAHIAWA HTS. -GLEN AVENUE	1	2
49	UMI-CBD (Continuation of Lines 1, 2, 3)	1	1
	Total	302	526

ROUTE NO.	ROUTE DESCRIPTION	MAX. VEH. REQUIRED 1980	MAX. VEH. REQUIRED 1995
EXPRESS BUSES:			
1	MAKAHA-MAILI-CBD	13	27
2	MAILI-NANAKULI-CBD	9	14
3	MAKAKILO-CBD	4	13
4	MILILANI-CBD	3	8
5	WAHIAWA-CBD	12	15
7	WAIMANALO-CBD	7	23
8	KANEOHE-KALHI	19	26
9	KAILUA-CBD	15	26
11	KAHALUU-KALIHI-CBD	19	36
13	HEEIA-KALIHI-CBD	20	34
15	LUNALILO HOME ROAD-CBD	2	4
16	HAWAII KAI DRIVE-UH	6	20
17	HAWAII KAI DRIVE-CBD	15	46
18	PEARL CITY-CBD	7	13
	Total	151	305

TABLE 5

PEAK HOUR BUS VOLUME ON MAJOR ROUTES

BUS ROUTES	ONE-WAY PEAK DIRECTION BUS VOLUME BY LOCATION							
	Nuuanu-Bethel		Bethel-Bishop		Bishop-Richard		Richard-Punchbowl	
	1980	1995	1980	1995	1980	1995	1980	1995
LOCAL BUSES								
Beretania	-	-	-	-	-	-	92	150
Hotel	120	202	115	194	90	148	-	-
King	-	-	-	-	-	-	92	150
Merchant	15	22	15	22	-	-	-	-
Queen	-	-	15	22	15	22	21	30
Ala Moana/Nimitz	-	-	-	-	27	49	27	49
EXPRESS BUSES								
Vineyard	94	162	-	-	34	84	13	38
Beretania	94	162	-	-	-	-	-	-
King	-	-	-	-	-	-	-	-
Merchant	94	162	-	-	21	46	-	-
Queen	-	-	-	-	13	38	13	38
Ala Moana/Nimitz	-	-	-	-	-	-	-	-

the volumes, more than 100 buses per hour would result if the buses were routed on the most desirable streets. However, based on studies conducted by the City Department of Transportation Services, it was found that a practical maximum capacity of a bus lane on urban Honolulu streets was approximately 90 buses per hour. Therefore, with the capacity of a single bus lane estimated to be approximately 90 buses per hour, and assuming that only one bus lane would be available on any street, the excess buses would have to be assigned to other streets.

Each bus route was again analyzed to identify the bus lines and number of buses that could be re-routed to other streets. The results of this analysis are shown on Exhibits 1 through 4 for the four time periods from 1980 to 1995.

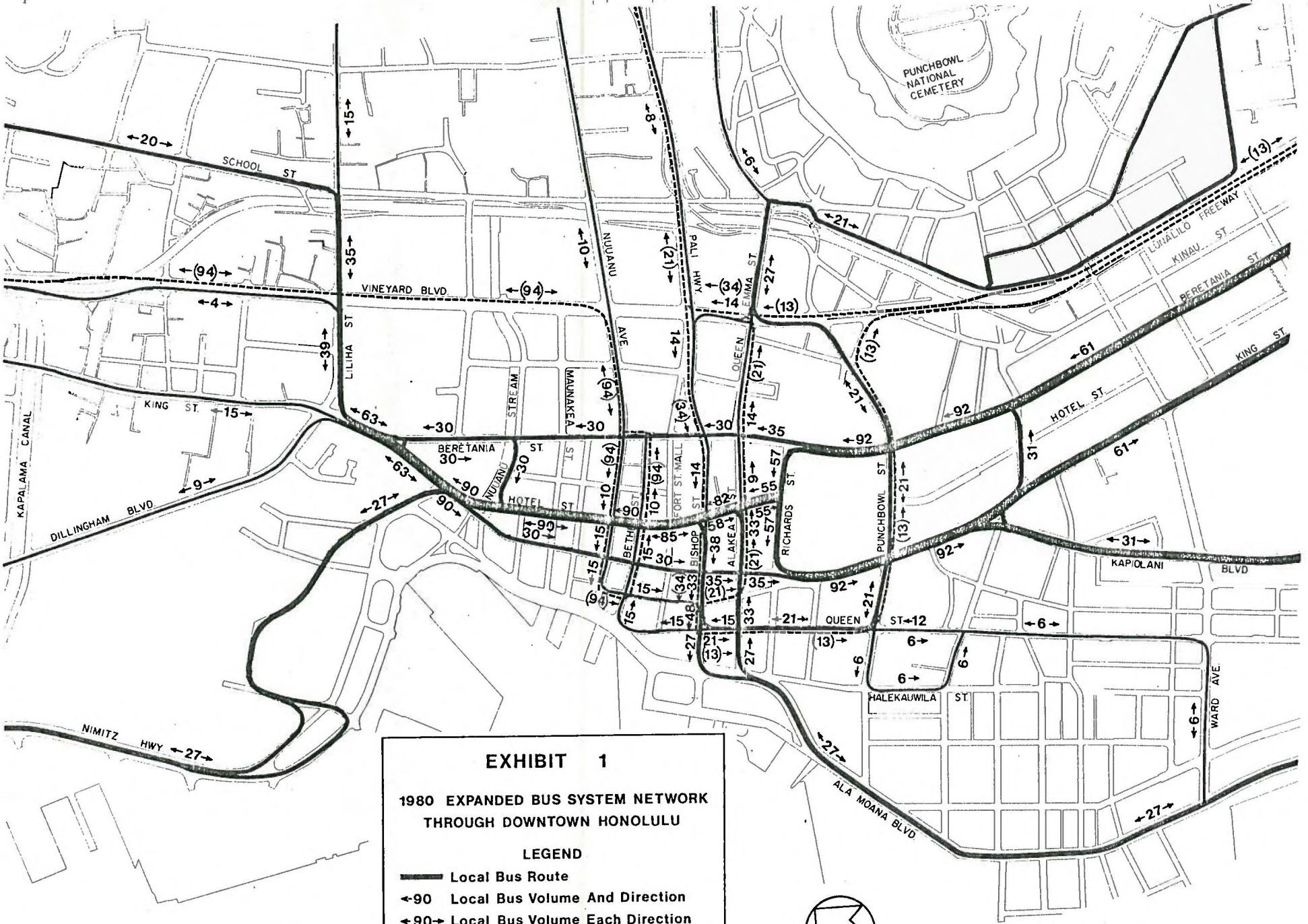


EXHIBIT 1

1980 EXPANDED BUS SYSTEM NETWORK THROUGH DOWNTOWN HONOLULU

LEGEND

- Local Bus Route
- ←90 Local Bus Volume And Direction
- ←90→ Local Bus Volume Each Direction
- ------ Express Bus Route
- ←(90) Express Bus Volume And Direction
- ←(90)→ Express Bus Volume Each Direction

NOTE: Peak Hour Volumes

NOTE: Expanded Bus System developed for study purposes only. Not adopted officially by City.

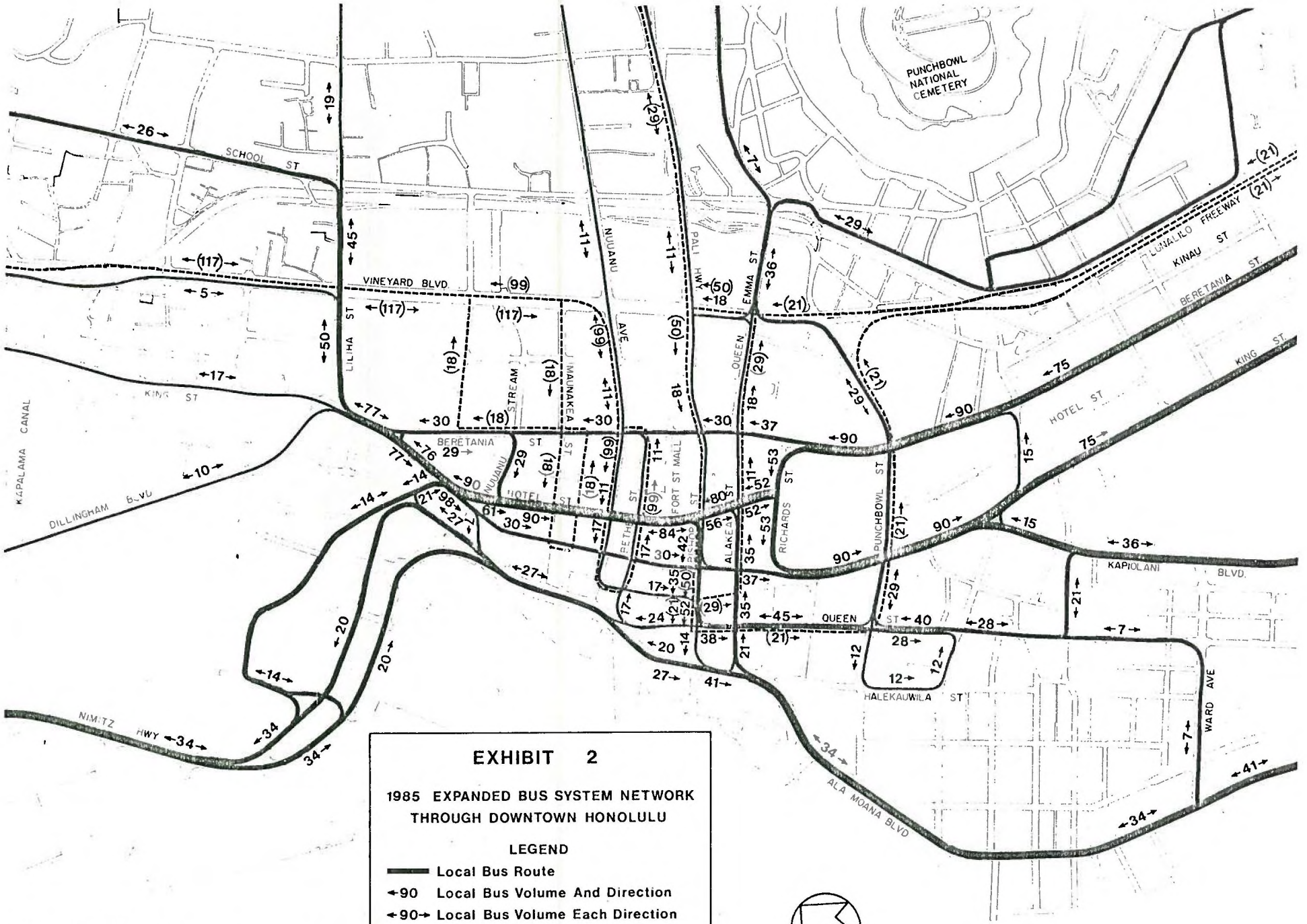


EXHIBIT 2

1985 EXPANDED BUS SYSTEM NETWORK THROUGH DOWNTOWN HONOLULU

LEGEND

- Local Bus Route
- ←90 Local Bus Volume And Direction
- ←90→ Local Bus Volume Each Direction
- ------ Express Bus Route
- ←(90) Express Bus Volume And Direction
- ←(90)→ Express Bus Volume Each Direction

NOTE: Peak Hour Volumes

NOTE: Expanded Bus System developed for study purposes only. Not adopted officially by City.

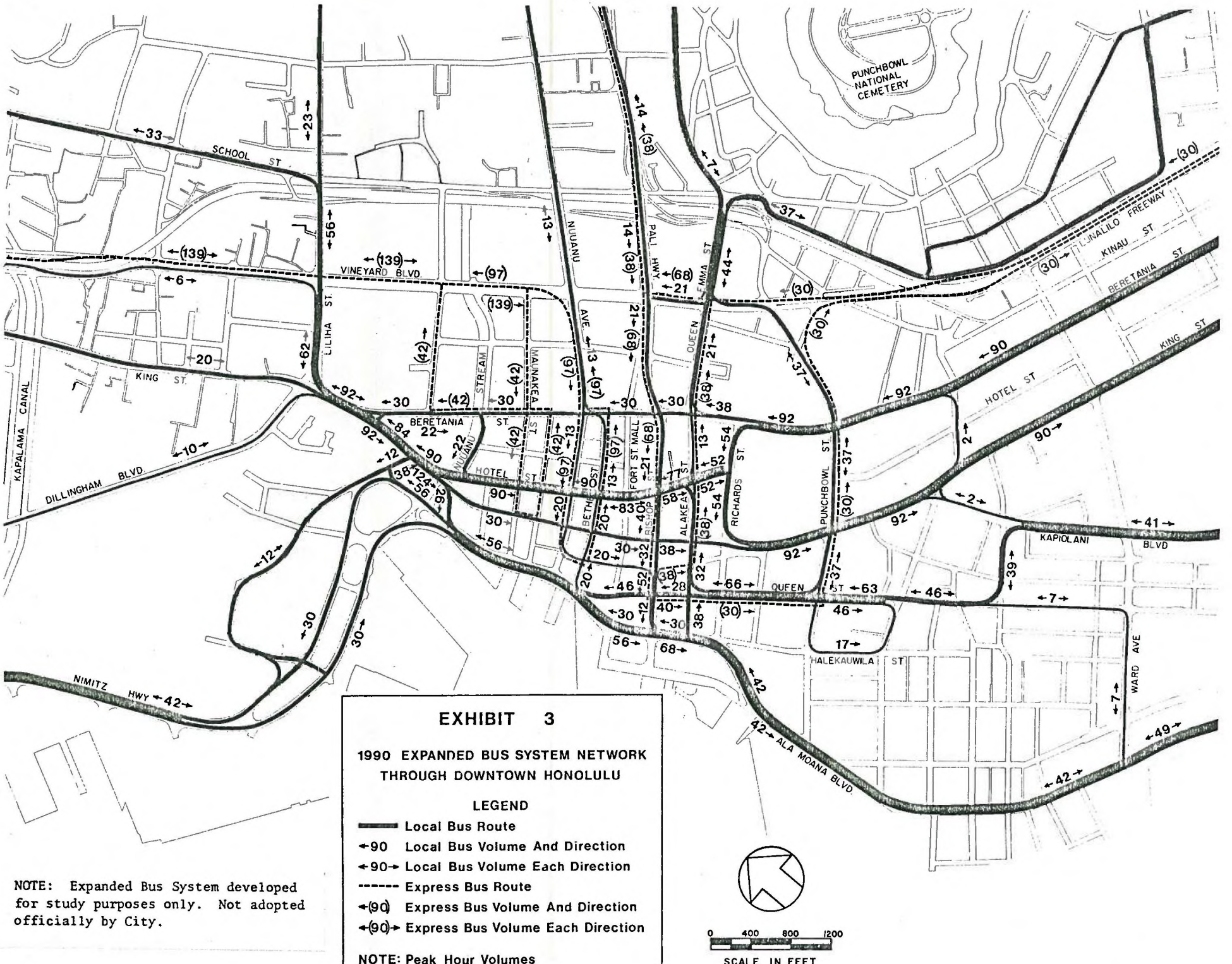


EXHIBIT 3

1990 EXPANDED BUS SYSTEM NETWORK THROUGH DOWNTOWN HONOLULU

LEGEND

- Local Bus Route
- ←90 Local Bus Volume And Direction
- ←90→ Local Bus Volume Each Direction
- ------ Express Bus Route
- ←(90) Express Bus Volume And Direction
- ←(90)→ Express Bus Volume Each Direction

NOTE: Peak Hour Volumes

NOTE: Expanded Bus System developed for study purposes only. Not adopted officially by City.

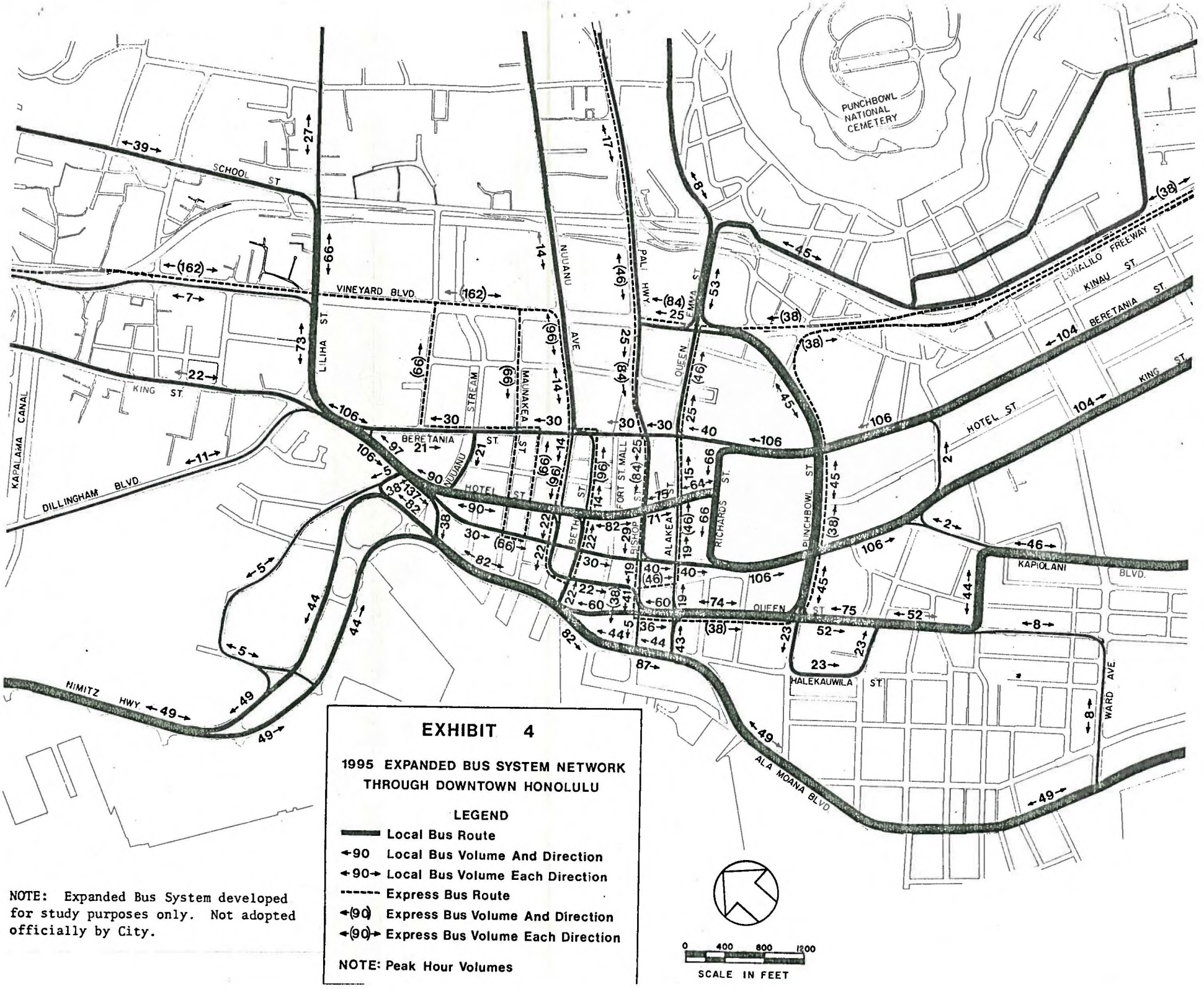


EXHIBIT 4

1995 EXPANDED BUS SYSTEM NETWORK THROUGH DOWNTOWN HONOLULU

LEGEND

- Local Bus Route
- ←90 Local Bus Volume And Direction
- ←90→ Local Bus Volume Each Direction
- ------ Express Bus Route
- ←(90) Express Bus Volume And Direction
- ←(90)→ Express Bus Volume Each Direction

NOTE: Peak Hour Volumes

NOTE: Expanded Bus System developed for study purposes only. Not adopted officially by City.

Downtown Honolulu is defined as bounded by Beretania Street on the north and Nimitz Highway/Ala Moana Boulevard on the south. For the east-west movements, only the King & Beretania Streets and Nimitz Highway/Ala Moana Boulevard exist as major arterials, supplemented by Queen Street which merges into Nimitz Highway. Hotel Street is a narrow discontinuous street with relatively little auto volume on it. Consequently, Hotel Street will be used as a bus mall and being the most centrally located of all east-west streets, it will be utilized to handle the maximum number of buses that it can physically take. This approach is necessary in order to minimize the number of buses to be placed on the major arterials such that maximum auto-carrying capacity is retained.

As can be readily seen from the series of graphics presented, Hotel Street reaches its physical capacity by 1980 with a number of buses from various routes diverted to other streets, namely King and Beretania Streets. By 1985, Beretania Street at Punchbowl Street cannot accommodate all the buses from Beretania Street and Kapiolani Boulevard thus requiring portions of the Kapiolani route buses to be routed through the CBD on Queen Street. Due to this constraint, by 1990 nearly all the buses on Kapiolani Boulevard are required to be re-routed to Queen Street. Furthermore, consideration was given to King and Beretania Streets as the primary

arterials through downtown Honolulu by minimizing the number of buses in order to maintain maximum capacity for autos.

Table 6 shows the total peak hour bus volumes at critical links of the major bus route streets. The bus volumes reflect the combined local and express buses and are given for the four time periods between 1980 and 1995.

TABLE 6

TOTAL PEAK HOUR BUS VOLUMES AT CRITICAL LINKS

	BUSES/HOUR IN PEAK DIRECTION			
	1980	1985	1990	1995
Beretania St.	92	90	92	106
Hotel St.	90	90	90	90
King St.	92	90	92	106
Merchant St.	15(+94)	17(+99)	20(+97)	22(+96)
Queen St.	21(+13)	45(+21)	66(+30)	74(+38)
Ala Moana/Nimitz	27	41	68	87
Nuuanu Ave.	15(+94)	17(+99)	20(+97)	22(+96)
Bethel St.	15(+94)	17(+99)	20(+97)	22(+96)
Bishop St.	38(+34)	42(+50)	40(+68)	29(+84)
Alakea St.	33(+21)	35(+29)	32(+38)	19(+46)
Richard St.	57	53	54	66
Punchbowl St.	21(+13)	29(+21)	37(+30)	45(+30)

Note: Numbers in parenthesis denotes the number of express buses operating on the street at the critical link.

3. Comparison of System Productivity & Costs

Any transport system that can utilize existing facilities is an attractive alternative to that requiring a totally new facility. It is attractive in that it normally requires much less capital expenditures and causes less community disruption. It stands to reason why local and federal governments require full assurance that maximum use of existing facilities are being made before any commitment is made for a new facility.

Most private and public investments in new plants or equipment are made to obtain greater productivity at a higher rate of efficiency. Public transit also requires major capital investments in order to attain greater productivity in terms of attracting higher ridership and at a lower unit cost for carrying each rider. As shown in Table 7, the investment in a new facility, whether it be fixed guideway or busway, results in greater productivity or higher ridership than the expanded bus system.

TABLE 7
ANNUAL RIDERSHIP PROJECTIONS
(millions)

	1980	1985	1990	1995
Expanded Bus System	70.0	83.6	97.3	110.9
Busway	72.4	94.2	116.0	137.8
Fixed Guideway	74.6	97.4	118.6	142.9

Lower production cost is also a key factor in making capital investments. Buses operating on existing streets, even with TSM improvements, travel at much lower speeds than vehicles operating on exclusive, grade-separated rights-of-way (ROW). Furthermore, vehicles operating on exclusive, grade-separated ROW are not restricted in size or length and in its operations such as using trained units. For high volume corridors, such as that projected for central Honolulu, a system utilizing exclusive grade-separated ROW could result in lower operating cost per passenger than the bus system operating on existing streets and highways. Table 8 shows the cost comparison of system alternatives.

TABLE 8
COST COMPARISON OF ALTERNATIVE SYSTEMS

	Expanded Bus		7-Mi. Busway		14-Mi. Fixed Gwy.	
	1985	1990	1985	1990	1985	1990
Annual Operating Cost**	47.0	57.0	42.0	53.0	40.0	48.0
Cost Per Passenger	56¢	58¢	45¢	45¢	41¢	40¢

In order to obtain lower operating costs, capital investment must be made in acquiring rights-of-way and constructing the grade-separated facility. Depending on the ridership volume and the condition of available streets and highways for bus operations, a point is reached whereby the investment in exclusive, grade-separated transit facility becomes economically justified. Where a natural, high volume travel corridor exists in an area together with a propensity for transit usage as exists in central Honolulu, this investment becomes warranted even with a relatively small metropolitan population.

From Table 9, it can be readily seen that the investment in the 14-mile fixed guideway becomes economically advantageous between 1985 and 1990 based on using constant 1977 dollar operating costs and current fare revenues. However, if operating costs and fare revenues are both escalated at 8% per year, then the fixed guideway investment becomes economically justified even before 1985. Of course in making economic analysis, it is more appropriate to use constant dollars in lieu of escalated dollars.

TABLE 9
COMPARISON OF COST & REVENUE

CONSTANT 1977 DOLLAR OPERATING COST & REVENUE

	Expanded Bus		7-Mi. Busway		14-Mi. Fixed Gwy.	
	1985	1990	1985	1990	1985	1990
Annual Capital Cost*	1.0	2.0	9.5	10.5	12.5	13.5
Annual Operating Cost	47.0	57.0	42.0	53.0	40.0	48.0
Total Annual Cost	48.0	59.0	51.5	63.5	52.5	61.5
Revenue (current fare)	17.3	20.2	19.9	24.9	20.8	26.1
Net Annual Cost	30.7	38.8	31.6	38.6	31.7	35.4

ESCALATED OPERATING COST & REVENUE

Annual Capital Cost*	1.0	2.0	9.5	10.5	12.5	13.5
Annual Operating Cost**	86.9	155.0	77.7	144.2	74.0	130.6
Total Annual Cost	87.9	157.0	87.2	154.7	86.5	144.1
Fare Revenue***	32.0	54.9	36.8	67.7	38.5	71.0
Net Annual Cost	55.9	102.1	50.4	87.0	48.0	73.1

* Based on 20% local share of capital cost and amortized over 25 years @ 6%

** Based on Escalated Cost at 8% per year

*** Revenue based on current fares increased at 8% per year

4. Impact on Street & Highway Capacity

Roadway capacity will be reduced with increasing volume of buses on streets and highways. Based on the Highway Capacity Manual developed by the Highway Research Board, approximately 90 buses per hour operating on a downtown street will effectively eliminate a lane from auto use. Approximately 50 buses per hour will reduce the effective auto-carrying capacity of the lane by 50%. Table 10 shows the available auto capacity of the major streets in downtown Honolulu based on the bus volumes currently operating in the area and the reduction in their capacities as the bus volumes increase to those projected for the year 1990.

The roadway capacity of the downtown streets in the east-west and north-south directions will be reduced by approximately 17% and 16% respectively. Using the most current population and employment projections, they reflect about a 1-3/4% annual growth or approximately 25% growth by 1990. This could conservatively be translated into a 25% increase in downtown traffic over today's conditions. A 25% increase in traffic volume on a street system with an expected decrease in capacity to approximately 85% of what is available today will give a relative increase of some 40% over today's traffic conditions.

TABLE 10

EFFECTS OF BUSES ON DOWNTOWN STREET CAPACITY* FOR AUTOMOBILES

EAST-WEST STREETS:

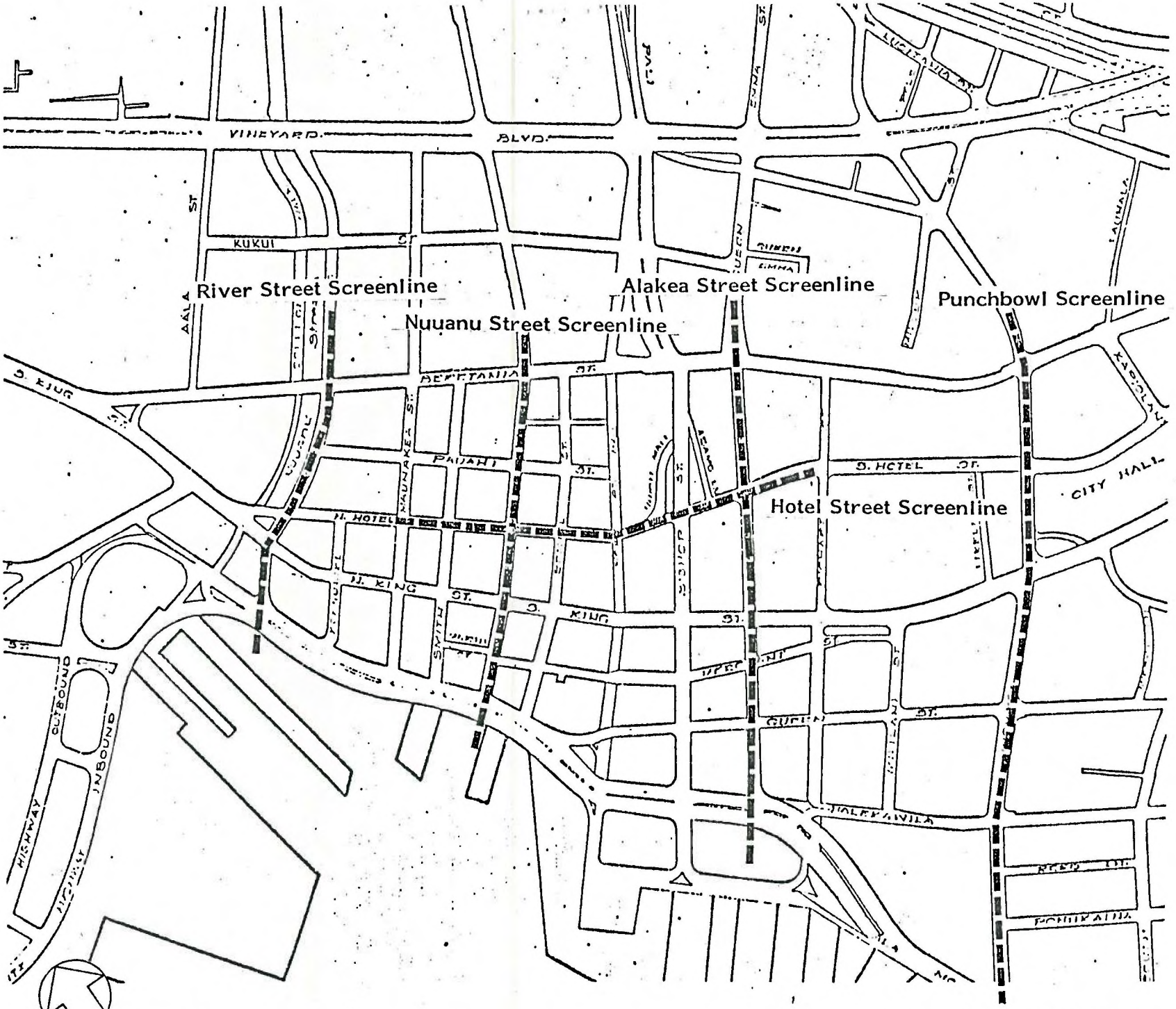
Screenline**	EASTBOUND			WESTBOUND		
	Capacity of Exist. Condition	Capacity of 1990 Condition	% Reduced	Capacity of Exist. Condition	Capacity of 1990 Condition	% Reduced
River Street	7810	6580	16	6140	4820	21
Nuuanu Avenue	5860	4620	21	7840	6450	18
Alakea Street	7180	5660	21	8140	6760	17
Punchbowl Street	7610	6720	12	6990	6380	9

NORTH-SOUTH STREETS:

Screenline**	SOUTHBOUND			NORTHBOUND		
	Capacity of Exist. Condition	Capacity of 1990 Condition	% Reduced	Capacity of Exist. Condition	Capacity of 1990 Condition	% Reduced
Hotel Street	5020	4130	18	4870	4180	14

* Capacity in vehicles per hour at Level of Service "E".

** See Exhibit 5 for screenline location.



CRITICAL SCREENLINE LOCATIONS
IN DOWNTOWN HONOLULU

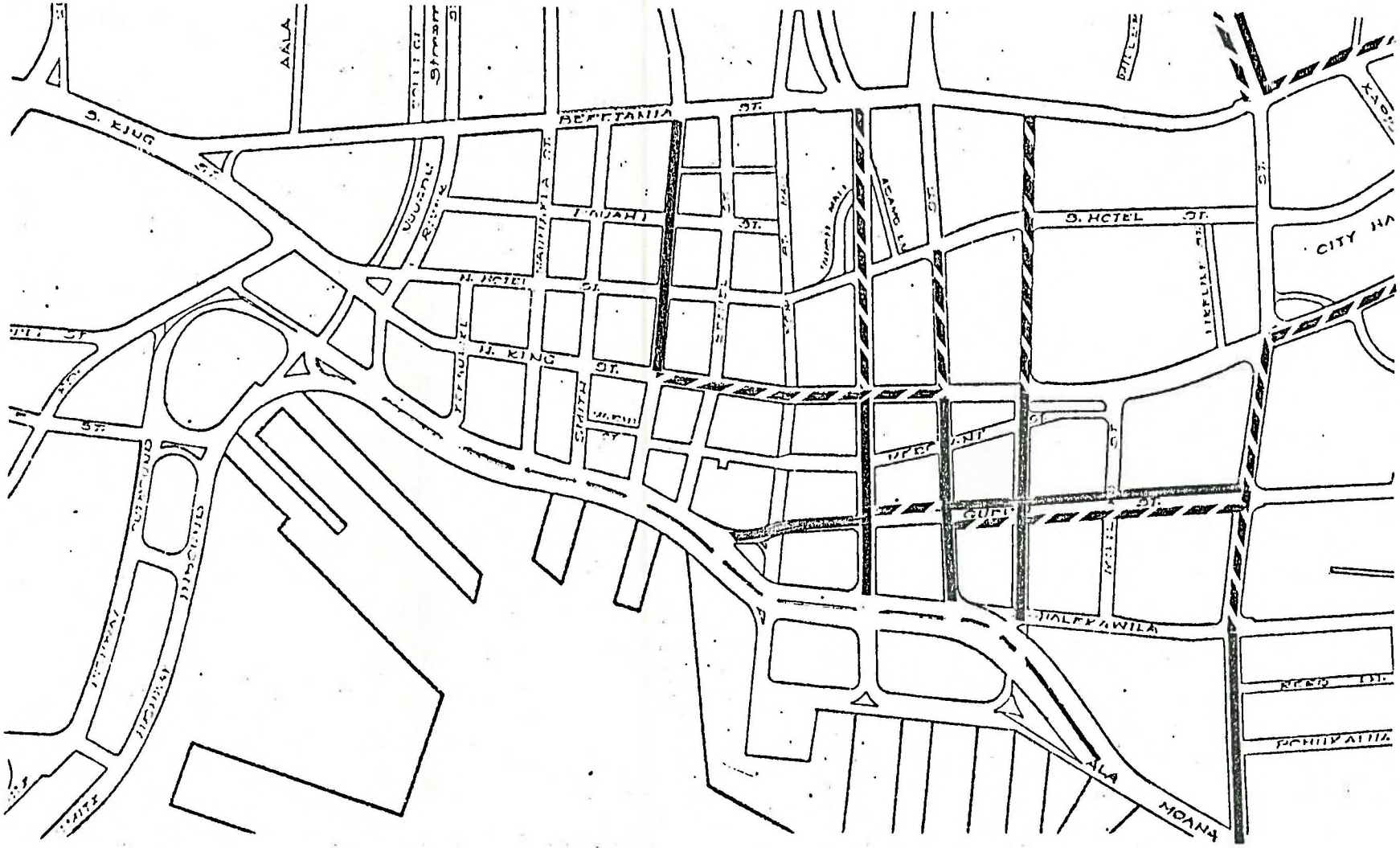
EXHIBIT 5

A review of today's traffic volumes and street capacities in the downtown area would indicate that many major downtown streets are near or at the design capacities. This can be seen in Exhibit 6 which identifies those streets which are operating at either level of service D or E. The determination of level of service were made based upon average operating speed on each roadway obtained during a 1977 speed and delay study conducted by the Department of Transportation Services and Table 11 obtained from the Highway Capacity Manual. As traffic volumes approach and exceed available street capacities, not only is operating speed reduced, but also the heavy peak congestion periods will be prolonged.

TABLE 11 –LEVELS OF SERVICE FOR DOWNTOWN STREETS

LEVEL OF SERVICE	TRAFFIC FLOW CONDITIONS (APPROXIMATIONS, NOT RIGID CRITERIA)	
	DESCRIPTION	AVERAGE OVERALL SPEED (MPH)
A	Free flow (relatively; some stops will occur)	≥25
B	Stable flow (delays not unreasonable)	≥20
C	Stable flow (delays significant but acceptable)	≥15
D	Approaching unstable flow (delays tolerable)	≥10
E	Unstable flow (congestion not due to back-ups ahead)	Below 10 but moving
F	Forced flow (jammed)	Stop-and-go

Source: Highway Capacity Manual



LEGEND

- Level of Service D
- Level of Service E and Below

0 250 500 1000

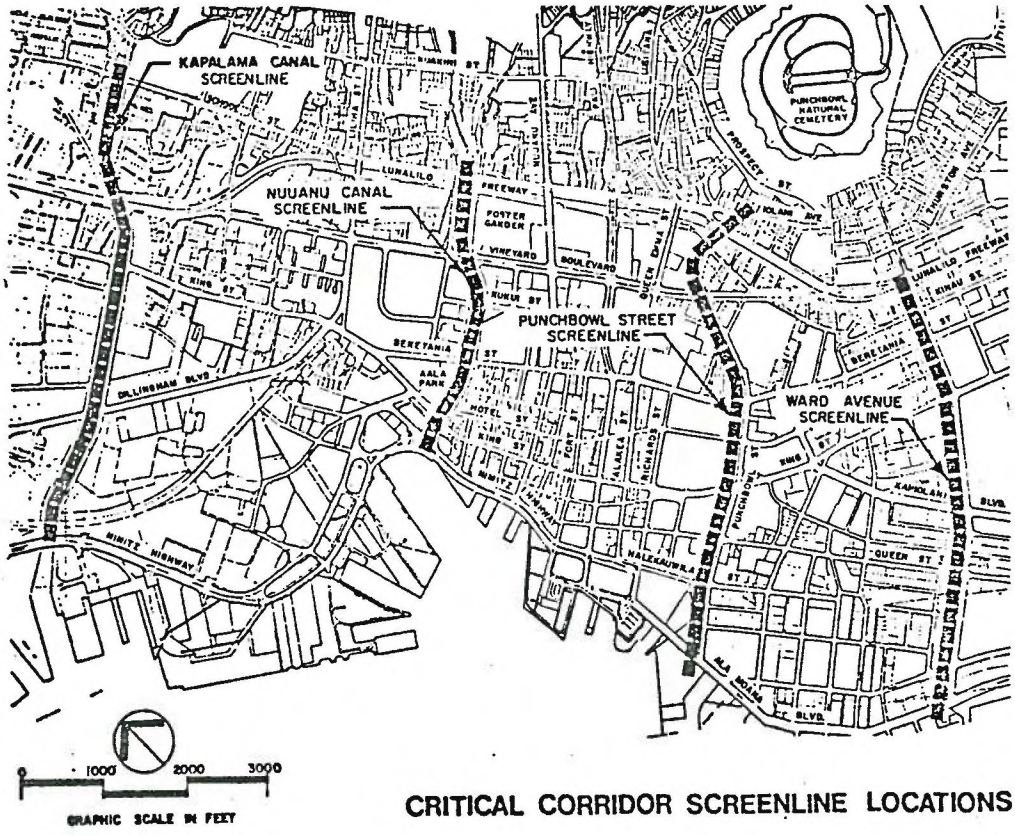
Graphic Scale in Feet

EXISTING CONDITIONS OF DOWNTOWN STREETS DURING P.M. PEAK HOUR

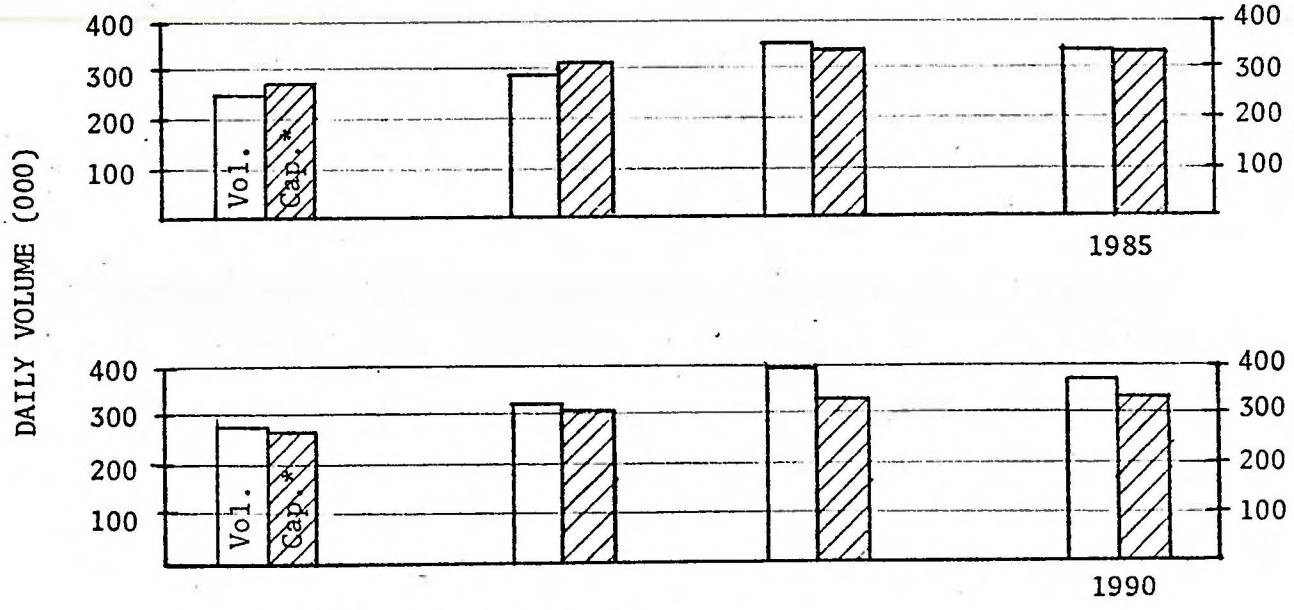
EXHIBIT 6

Equally critical as the downtown streets are the major arterials and highways that carry autos destined to and points beyond the downtown area. A screenline analysis was conducted to relate projected auto volumes to roadway capacities which reflect various TSM improvements. The analysis shows that in 1985, the projected traffic volumes are near or at the capacity at critical screenlines and that by 1990, the volumes exceed available capacities as shown in Exhibit 7.

As stated earlier, as traffic volume exceeds available capacity what actually occurs is a prolonging of the heavy peak congestion periods. This phenomenon can be easily seen in Exhibit 8 which shows the distribution of traffic volume during the A.M. peak periods as daily traffic volume increases on Moanalua Highway. As seen in the exhibit, as traffic volume reaches the roadway capacity, it tends to spread out over a longer period. For example, in 1974 the a.m. peak hour occurred between 7 a.m. and 8 a.m. with traffic volume operating in the range of level of Service E. By 1976, traffic had grown such that the same traffic volume that formed the 1974 peak hour volume was reached and exceeded over a longer period. This period lasted for 2-1/2 hours, or 2.5 times longer than in 1974. This means that the auto driver must either leave his home much earlier or later to miss the peak or that the effects of traffic congestion will exist over a longer period of time and affect a greater number of auto drivers.



CRITICAL CORRIDOR SCREENLINE LOCATIONS

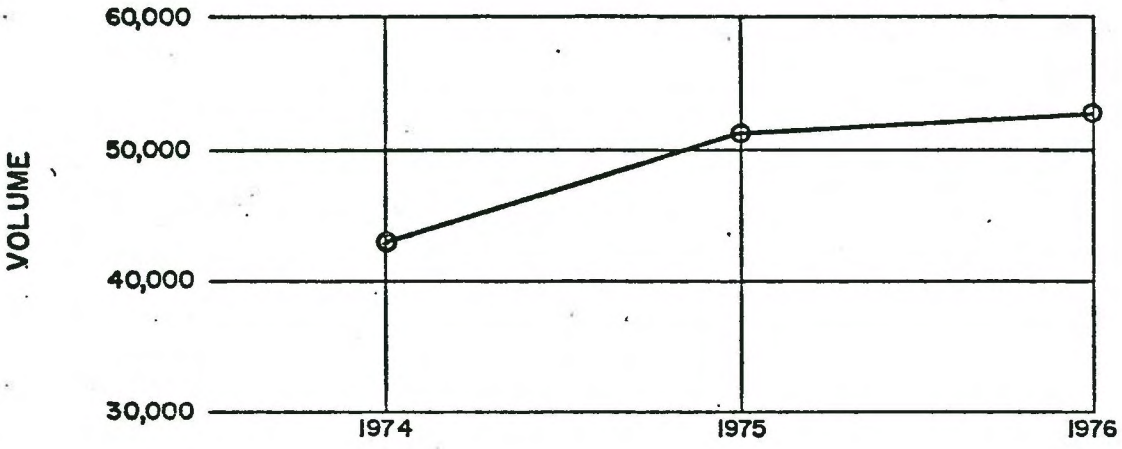


* Capacity @ Level of Service E

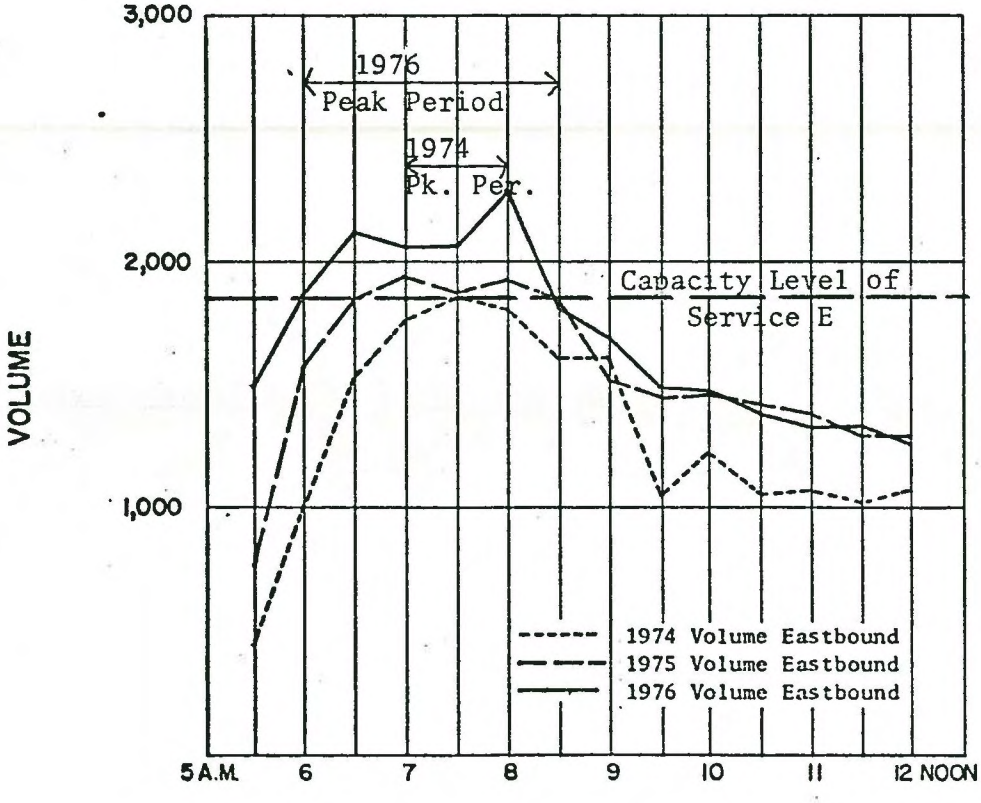
HIGHWAY & STREET NETWORK CAPACITY ANALYSIS

EXHIBIT 7

TOTAL DAILY TRAFFIC VOLUME



ONE-HALF HOUR TRAFFIC VOLUME-KOKOHEAD BOUND



TRAFFIC VOLUME GROWTH TRENDS ON MOANALUA HIGHWAY (At Moanalua Stream)

EXHIBIT 8

5. Future Urban Growth & Development Implications

Future land use and development policies for Oahu are set forth in the new General Plan which allocates population and employment levels for various geographical areas of the island. The Central Honolulu district, which is currently highly developed, some one third or more of all future growth is planned to take place in this district. To accommodate this population growth, it is envisioned that most of it would occur through redevelopment of existing improved areas with higher density developments especially along the proposed rapid transit corridor. The population and employment levels established for Central Honolulu is predicated on the availability of a high-capacity rapid transit system to complement the existing and planned street and highway system. It was estimated that a rapid transit system capacity of some 30,000 persons per hour would be required to meet future travel demands.

Improvements to existing transportation systems will play a vital role in the support of the land use and development policies of the new General Plan. The type of transportation system and the time frame for its implementation will also be critical in determining how well the transportation system can support the General Plan policies. The implementation of the General Plan will be aided by a series of detailed Development Plans which is currently

under preparation. A formal commitment to the type of future transportation system and its general location are necessary inputs for the development of these Plans. It would be difficult, if not impossible, to develop a realistic and implementable Plan without first defining the basic transportation scheme. For example, if a high capacity rapid transit were not to be included, densities needed to reach desired population levels may not be attainable and therefore they may be lowered in Central Honolulu and the growth directed to some other area.

Delaying the implementation of the rapid transit system could also have some long-term effects on the growth and development of Central Honolulu. Since central Honolulu is projected to reach its maximum population and employment levels by the year 2000, a delay of some 10 years would mean that approximately 50% of future growth may have taken place before rapid transit service is available. This growth would then have taken place without the influence of rapid transit to shape development which would be comparable with the future transportation shape development which would be comparable with the future transportation system. The implications of this situation would be that future transportation costs would be more expensive and more importantly, the quality of the urban environment may be less than that attainable if rapid transit had been available.

If Central Honolulu is to accommodate more growth as set forth in the General Plan policy, it must be provided with more transportation capacity than that available from existing streets and highways. If rapid transit is the only viable system capable of providing this needed capacity, then it should be committed for implementation at the earliest possible date such that transportation and land use planning can be coordinated to achieve desired urban form which can be supported by an efficient transportation system.